Bright Agrotech, LLC

Educator's Packet

Prepared August 1st, 2014 by Perry Baptista and Amy Storey

Table of Contents

How are ZipGrow towers being used in the classroom?

Need inspiration? Take a look at how teachers are using ZipGrow towers to teach a variety of courses and age levels.

Dan Hughes

Location: Michigan
Grades: 7th and 8th
Course: Ecology (elective)
System type: Aquaponics

Mr. Hughes sacrificed his own desk space to make room for an aquaponics system right on the wall of his classroom. Now that's dedication to improve learning and teaching!

Vertical and horizontal aquaponics are both demonstrated in this in-class setup. Their setup includes a 550 gallon reservoir for fish, two 50-gallon grow beds above the reservoir, and ZipGrow towers hanging over top. Three T5 grow lights shine upon the plants.

The system is brand new for the 2014-2015 school year. Already, system design provided an independent study project for one student. Mr. Hughes plans to use the system to teach the Nitrogen Cycle, the relationship between plants and animals, and sustainability to his 7th and 8th grade ecology students.

In the future, they hope to seek funding for a school greenhouse.

Contact Dan: dan.hughes@has-k12.org

Kevin Savage

Location: Ohio
Grades: 9th – 12th
Courses: Biology, Chemistry, Environmental Science
System type: Aquaponics

Cincinatti Hills Christian Academy has a 12 ZipGrow Tower system *in addition to* three other aquaponic and barrelponic systems in their complete aquaponics lab. (We're jealous!) The ZipGrow system is stocked with tilapia and used for both classroom instruction and student-based research on vertical farming.

Since each system in the lab has unique characteristics, student lab groups will be assigned to each system for the semester or school year. They are responsible for each system's operation and maintenance.

The concepts and courses supported by the aquaponics systems are extensive. According to Kevin:

> *We begin using aquaponics with our freshman in Biology to support teaching of aquatic ecosystems, intro to microbiology, intro to botany, cellular biology, photosynthesis, etc. Our sophomore students take chemistry, and we use the aquaponics systems to teach about pH, oxidation-reduction reactions, etc. All of our "hands-on" construction and system operations aquaponics activities take place as a part of our Environmental Science I & II course sequence (Sustainable and Urban Agriculture), or as a component of independent student research.*

Kevin has recent aquaponics presentations available on his LinkedIn page and tweets regularly about his aquaponic activities during the school year.

Contact Kevin: kevin.savage@chca-oh.org
LinkedIn: Kevin Savage
Twitter: @kevin_savage

What can you learn from ZipGrow towers?

Need a place to get started? Here's a list of concepts that can be taught with ZipGrow towers and products. Use your imagination – we're sure we forgot a few!

Agriculture

Greenhouse management
Pest management
Plant disease/health
Urban Agriculture

Biology

Aquatic ecosystems
Diseases and viruses
Fish biology and lifecycle
Germination
Microbiology *(including bacteria, fungi, and algae)*
Nitrification
Plant growth *(Break apart root and foliage growth!)*
Plant lifecycle
Symbiotic relationships

Chemistry

Light properties and manipulation
Oxidation-reduction reactions
pH
Plant nutrients

Other Science

Botany
Ecology
Environmental science
Experimental design
Scientific process

Family and Consumer Sciences

Cooking and healthy eating

Business

Administration/management/planning
Business planning
Finance
Marketing

Math

Calculating yields, water needs, and similar problems
Making change
Charting
Graphing

History

Agricultural development
Industrial development

Other

Automation
Construction and design *(including plumbing, heating, electrical, rack building, greenhouse building, etc.)*
Calculating heat needs and R-values
Landscape design
Problem solving/critical thinking/troubleshooting
Sustainability

Remember: a Hydroponic System can benefit multiple classes!

Almost all of the teachers we talked to were using their hydroponic or aquaponic systems as a part of multiple courses, following students throughout their time at the school. Work with other teachers and coordinate a team hydroponic effort.

Testable and Measurable Outcomes

System testing and measurement keeps the students involved while the plants grow. Here are a few ideas for ongoing measurements and projects. Many of these tests (like pH and EC) should be performed regularly to monitor system health; however, if you are using a Spring System and Dyna-Gro pre-formulated nutrient solution, regular testing is not as necessary as in a larger system.

pH
Electro-Conductivity (EC) *(also measures the solutes/salts in the system)*
Nutrient testing
Plant growth
Plant weight at harvest, wet and dry
Harvest quantities

Use charts, tables, or graphs to help students visualize this data.

Best Plants for ZipGrow Towers

Don't know what to grow in your ZipGrow tower? Here's a place to get started. While these are the easiest plants for beginners, almost anything will grow in a tower. Feel free to experiment with other crops.

Our Top Picks

Basil *(miniature varieties work especially well)*
Mint

Herbs

Chives
Parsley
Cilantro
Oregano

Greens

Lettuce *(all varieties are great!)*
Bok Choy
Mustard greens
Collard greens
Kale
Chard

Fruit-bearing crops

Most fruit-bearing crops will require additional trellising and support in order to grow vertically! We recommend starting with greens and herbs.

Tomatoes *(try cherry tomatoes)*
Summer squash
Strawberries

Flowers

Marigolds *(also provide natural pest control in a system)*
Zinnias

Root Crops

While any root crop will grow well in a ZipGrow towers, tap roots do not develop as desired in the Matrix Media. We recommend starting with the above crops.

Lesson Plans

1. "Why Hydroponics?" Lesson Plan

Dear Educators,

The following material for the "Why Hydroponics" lesson plan covers a number of topics, each with 1) an explanatory paragraph, 2) discussion questions for one of the bulleted subjects, and 3) further resources for student (or teacher) research. At the end of the lesson(s) is an activity idea and outline for students to gain hands-on experience. These notes are meant to accompany the attached "Why Hydroponics?" presentation slides.

We hope that this material is helpful to you and encourage you to tweak and adapt it to fit your classroom. Best of luck!

- The Bright Agrotech Educational Team -

Disciplines:

Math, Chemistry, Biology, Geology, Business, and Critical Thinking

Summary/Lesson Outline:

- Population Growth
- Agricultural Space Needs
- Agricultural Water Needs
- Alternative Growing Techniques
- What is Hydroponics?
- Challenges of Vertical Hydroponics
- Putting the Knowledge to Use

Student Outcomes:

Students will be made aware of water and space limitations of conventional agriculture.

Students will analyze options to overcome conventional agricultural limitations.

Students will understand what hydroponics is and challenges to hydroponic production.

Students will demonstrate recognition of food production concerns by proposing a hydroponic system of their own that addresses said concerns.

Students are prepared to assemble the ZipGrow Spring System during the next class.

Goals:

Educate students on the world's agricultural needs and establish an understanding of progress necessary. Trigger critical thinking and problem solving by introducing relevant real-life challenges. Set the foundation for using hydroponics as a learning tool.

Lecture/Reading Segments:

Population Growth
Hundreds of thousands of babies are born each day - many more people are born than die, and the world population is growing. It's growing so fast that experts predict that in ten years (2024) the world's population will reach 8 billion people, and in 2040 the population will reach 9 billion!

Critical thinking: What other problems could arise from a growing population?
Mathematics: What is a linear line? Does population growth happen linearly?

Extra Resource: WorldOmeters

A great tool for analyzing population dynamics and other relevant world statistics. Includes a number of easy-to-read, interactive graphs.

Space Needs
People need more food, and food is produced through agriculture. We need to increase our agricultural output by nearly 130% (from current output) in the next 25 years, but we don't have enough space to do that using the growing techniques that are used right now.

We need more space? Some people think that "more space" means "more surface area", and only think of "space" as referring to area from side to side. But many innovative people have discovered that it's not more surface that we need. We can use the space above crops, and increase the number of plants grown without increasing the square footage. These creative growers use vertical farming. Vertical farming is growing crops on several levels. This could be by growing plants on shelves or racks, or in towers. This way, farmers can grow several plants in one square foot, where before they could only grow one.

Mathematics: What is the difference between square feet and cubic feet?

Critical Thinking: In what other ways could we utilize air space in the future? (What kind of technology could be moved from the ground to the air?) What kind of problems do you think people will encounter when developing these new technologies for the air?

Water Needs

Space isn't the only thing that the earth is running low on. Water is also a top concern. Between drought and complicated water rights issues, farmers as well as municipalities (towns) and industries can have a tough time getting the water they need to grow food, provide safe drinking water, and make products that require water as part of the production process. The lack of water is often a limiting factor for farmers, and current irrigation techniques are highly wasteful in water use. Much of the water used for growing ends up sinking into the soil or evaporating in the sun and wind. We need to create new ways of getting adequate water to crops without losing it in the soil and environment.

Math/Chemistry: What is a limiting factor?
Critical thinking: Do you think that space or water is the top limiting factor for farmers? How could you decide which one was more limiting by using information on plant needs?

Extra Resource: Water Use Efficiency in Hydroponics and Aquaponics

An short and informative article written at an 8th or 9th grade reading level.

Solving the Space and Water Problems With One Solution

For years, people have been experimenting with alternative growing techniques. In early Mesoamerica, the Aztecs grew crops using "chinampas", floating gardens on the lake Texcoco, and used the nutrient-rich mud from the bottom of the lake to fertilize the plants. The Chinese also harnessed the nutrients from water organisms in their rice paddies, which were flooded and housed a variety of water creatures. People began to realize that growing plants in soil wasn't the only option, and in Australia, the modern art of hydroponics was born.

Critical Thinking/Biology: Why do you think that the mud at the bottom of lakes, rivers, and ponds, has so many nutrients? Do you think that plants use fish waste directly, or is it processed in some way before the plants can use it? What organisms process nutrients? (Intro. to nitrification and nitrifying bacteria)

Extra Resource: A Timeline of Vertical Farming

Although written on vertical farming specifically, this interesting article is a neat insight to alternative agriculture techniques throughout history.

What is Hydroponics?

Hydroponics is simply growing crops without using soil. Hydroponic growers around the world have used several systems to accomplish this task. One is a raft system. In a raft system, plants are grown in some sort of raft with holes in it. The roots of the plants hang down into the water, where they are able to take up the nutrients that are present in the water or solution. Another type of hydroponics system is a grow bed system. This technique uses a type of shallow bin - called a grow bed - filled with a "media" other than soil. The media could be clay pellets, crushed rock, or expanded shale. Water is constantly run through the media by a pump, which pumps water to the grow bed from a sump tank. Then the water drains from the grow bed back into the sump, and is thus recirculated. The third way to grow plants in hydroponics is also the most practical. This method is vertical hydroponics, and when it is done correctly, it can save not only water, but space. Of course, when you combine vertical growing with hydroponics, a lot of complicated concepts go into the design, and over the years, inventors have had to solve a lot of problems.

Challenges of vertical growing techniques include:

Light extinction

Light extinction happens when the incoming light is used up by the crops at the top of the vertical system, and the bottom crops don't get enough light to grow. If only the top crops grow big enough to sell, growing multiple layers of plants is pointless.

Difficult maintenance

Systems with large components and a lot of water can get bulky and heavy. For example, a raft system uses huge water tanks which are nearly impossible to move around and can be difficult to navigate. Harvesting plants from these types of systems can be difficult, requiring many people and a lot of time. In the end, difficult maintenance is closely linked to labor costs.

Costs can be higher than revenue

Many costs go into production. When building a hydroponics system, a grower has to think about the labor costs, cost of equipment, cost of installation, water costs, electricity, space costs (renting, buying, or building a space), and the costs of inputs such as nutrient solutions. If a hydroponic system doesn't work efficiently to minimize these costs, the costs could outweigh the revenue. That would make the system nonviable on a large scale.

Chemistry: What is the difference between a liquid and a solution? Why is the water in a hydroponic system called a solution?

Geology/Chemistry: What is shale? How do you think it gets expanded? Are there other rocks that can be expanded, and what are they used for?
Critical Thinking: Why is it important that the water is recirculated? What is the other option beside recirculating water? How could you reduce any of these costs using smart system design?
Business: Why are labor costs important? How could you reduce labor costs for a raft or grow bed system? Categorize the costs listed into initial (or one-time) costs and periodical costs. (Weekly, monthly, or yearly bills.) How can you estimate whether or not revenue will outweigh these costs?

Problem Solving

After looking at all the challenges of vertical hydroponics, it's time to think critically about system design. We need a system that a) allows light to get to the bottom crops b) is light and easy to move around, and b) has low costs. Do you have any ideas?

Activity

Have students break into discussion groups. Given all these challenges, what do they think would be the perfect system for growing crops? Encourage them to be as creative as possible.

2. Hydroponic System Assembly Lesson Plan

Disciplines
Motor skills, teamwork, science, spatial reasoning

Summary
Students will work together to assemble the class' new hydroponic system.

Use this lesson after students have been introduced to hydroponics using the "Why Hydroponics?" lesson.

Student Outcomes
Students will gain practical assembly skills and develop teamwork skills. They will have hands-on experience with a hydroponic system and its components. They will analyze system efficiency.

Goals
Assemble the hydroponic system for future classroom use.

Activity
1. Start by reviewing system setup instructions with the students. Use the following resources as applicable for your system:
    a. Spring System Assembly: https://www.youtube.com/watch?v=EO61B1_bQ0Q
    b. Spring System Light Kit Assembly: https://www.youtube.com/watch?v=Tu18I-rim8E
    c. Building a Small Hydroponic System: http://www.slideshare.net/BrightAgrotech/assembling-a-vertical-aquaponics-system
    d. Building a Small Aquaponic System: http://www.slideshare.net/BrightAgrotech/hydroponics-setup-35450850
2. Break students into groups.
3. Have students assemble the system.
4. Reconvene for group discussion.

Discussion Questions
- How does this system address the concerns presented in the "Why Hydroponics?" lesson?
- What concerns does this system NOT address?

- Did you think assembly was easy or hard? How would you improve the construction process or design?
- Will this system work for growing all types of agricultural crops? Why or why not?
- Would the system efficiently grow all types of agricultural crops? Why or why not?

3. Seed Starting Lesson Plan

Disciplines
Biological Science, the Scientific Method, Math (graphing and charting), Public Speaking, Teamwork

Summary
Students will learn about seed starting and plant growth. They will design their own experiment and track seedling growth from planting to transplanting over a 4-6 week period. Student groups will select experimental variables and present findings to the class.

Student Outcomes
Students will gain hands-on, practical knowledge of seed starting and transplanting. They will understand plant growth, plant lifecycle, and the effect of water, light, and growing medium on seed growth.

Goals
Educate students on seedling growth. Produce transplants for the class' ZipGrow tower and future lessons.

Activity
1. Introduce the subject with a brief lecture on parts of the seed, seed growth, plant growth, or a related topic suited to the students' knowledge. Consider using this video blog post: http://verticalfoodblog.com/best-way-to-plant-seeds/
2. Divide students into groups of 3-4 students. Distribute seed starting trays, soil, and seeds among groups.
3. Have student groups decide which metrics they would like to track as their seedlings grow, such as height, weight, seedlings per plug, watering amount, light amount, etc.
4. Have students fill trays with soil, plant one seed per plug, and lightly cover with 1/8 inch – ¼ inch of soil. (Seeds for larger crops may need to be planted deeper. Refer to seed packet instructions.) Water, but do not overwater.
5. Water plants daily. Take observations as necessary.
6. Continue step 4 for 4-6 weeks, or until plants are ready to transplant. Take final observations before transplanting.
7. Have groups chart, plot, or graph their data and present findings to the class.

Discussion Questions

- If plants did not grow successfully, why do you think the seed starting failed? What could be done to improve seedling growth?
- Which do you think is most important to producing healthy transplants: water, light, or soil? Why? Will these factors change as seedlings grow and are transplanted?
- How could you improve the seed starting process?

Products and Pricing for Educators

Buying for the classroom? Take 15% off at our online store using the Educational Discount code **QE51T762N9W8.** Must use an education email address to qualify.

Shop now at shop.brightagrotech.com

BEST DEAL: Get the Custom Educator's Package

Bright Agrotech is happy to bundle a Spring, Spring System Light Kit, and Seed Starting Kit for educational producers. This product is specifically designed for classroom use. Available at steeply discounted prices! **Contact our office at (307) 766-6538 to order.** Please note: as components for the educator's package must be ordered in bulk, there may be a 2 week lead time for this product.

The Spring

Now you can grow fresh flowers, veggies, greens and herbs right in the classroom without sacrificing space. Everything you need – ZipGrow tower, media, pump, and instructions – is included. Works perfectly for indoor production when paired with a Spring System Light Kit.

The Spring.....	~~$199.95~~	$169.96
Spring System Light Kit.....	~~$179.95~~	$152.96

ZipGrow Towers

Use ZipGrow towers for your own greenhouse system. Setting up a greenhouse with more than 50 towers? Contact our office for bulk-rate pricing.

3' ZipGrow Tower.....	~~$49.95~~	$42.46
3' ZipGrow Tower 4-pack.....	~~$189.95~~	$161.46
5' ZipGrow Tower.....	~~$67.95~~	$57.76
5' ZipGrow Tower 4-pack.....	~~$257.95~~	$219.26
5' ZipGrow Tower 8-pack.....	~~$488.89~~	$415.56
5' ZipGrow Tower 12-pack.....	~~$734.85~~	$624.62

Pumps, Irrigation, Lights, and More

Check out shop.brightagrotech.com for more accessories, replacement parts, and tutorials.

Need help getting your system set up?

Click here for a video tutorial on Spring System setup, or click here for a video tutorial on light kit setup.

Bright Agrotech Resources

Our team strives to publish content that is educational, relevant, and appropriate for all ages. Consider assigning a reading from the Vertical Food Blog or using one of our many YouTube videos to supplement your instruction. The Nutrient Deficiency Key is just one resource that can be used as a hands-on tool and activity.

For more resources and links, check out resources.brightagrotech.com.

Contact Us

Bright Agrotech
1938 Harney St., Ste 152
Laramie, WY 82072

www.brightagrotech.com
info@brightagrotech.com
(307) 766-6538

Follow us

Bright Agrotech is always updating our social media! Follow us on:

	Username	URL
Facebook	Bright Agrotech	http://www.facebook.com/BrightAgrotech
Twitter	@BrightAgrotech	http://www.twitter.com/BrightAgrotech
Pinterest	Bright Agrotech	http://www.pinterest.com/brightagrotech/
	Soil-less Science Educators	http://www.pinterest.com/SoillessScience/
Instagram	bright_agrotech	http://instagram.com/bright_agrotech
LinkedIn	Bright Agrotech	http://www.linkedin.com/company/bright-agrotech